NASA's Land-Cover/Land Use Change Program: An Update

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Solicitations

- ROSES-2014: Multi-Source Land Imaging (MSLI)
  - 40 full proposals under review (one-step process)
    - 5-6 Selections are expected in early March 2015
- ROSES-2015: LCLUC
  - Two steps (1 step due Dec 1 2015; 2 step due Jun 1, 2015)
    - two elements:
      - LCLUC in South Asia – towards forming SARI Science Team
      - Synthesis

Landsat-8 – Sentinel-2 Synergy

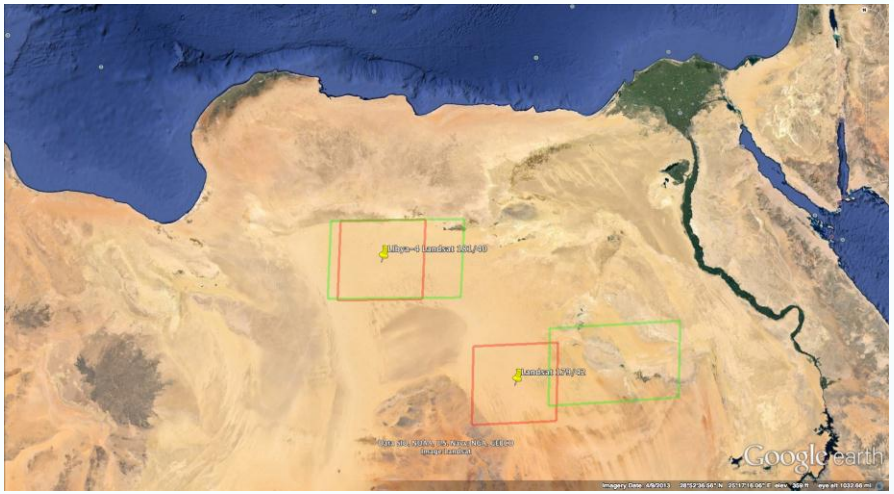
- Anticipated Results from Multi-Source Land Imaging Science Activities
  - Characterization of instrument performances using standard methods and metrics and undertake cross-calibration
  - Harmonization of data formats, standardization of the pre-processing algorithms, surface reflectance and derived products
  - Basic algorithms, customized as needed for individual instrument characteristics (radiometry, spatial resolution, swath width, etc.)

Landsat-8 – Sentinel-2 Synergy (cont.)

- geometrically-corrected, ortho-rectified, surface reflectance products going beyond the USGS Landsat 8 product
- validation using methods giving a common measure of product
- accuracy with established CEOS standard validation procedures
- easy downloading of large volumes of data
- alternatives to data downloading (e.g. the NASA NEX, Google Earth Engine).
- near real-time data delivery, which is important for rapidly changing land cover (e.g. flooded land, burned areas, forest cover change, agriculture), particularly in a land management, decision-making context

Instrument Performance

- Objective: to support the synergistic use of Landsat and Sentinel-2 data and to facilitate calibration compatibility between the L8/OLI and the S2/MSI
- Measurements on ESA reference diffuser at US and ESA calibration facilities
- US facilities
  - GSFC Code 618 Diffuser calibration facility for the VNIR wavelengths (Dec 2013 to March 2014)
  - University of Arizona Optics Laboratory focused primarily on the SWIR spectral ranges (March to July 2014)
- ESA facilities
  - Physikalisch Technische Budenanstalt, Germany
  - Centre Spatial de Liège at the University of Liège, Belgium



Predicted Near-Simultaneous S2a/L8 Pass over Libya-4 (181/40)

Surface Reflectance & Calibration

- Surrogate to the North African pseudo invariant calibration sites to actually measure the directional surface reflectance of the sand dunes in large field campaign in March
- Radiometric Calibration Test Site at Railroad Valley, Nevada, facility
- Work on updating the processing code for use with Sentinel–2 MSI

Algodones Dunes, Ca

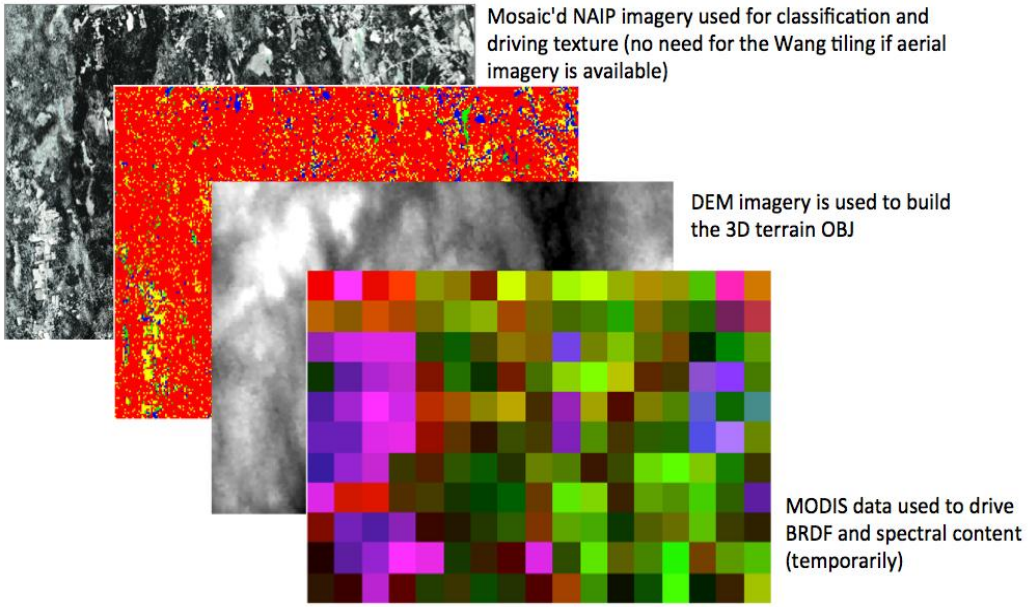
Processing Techniques

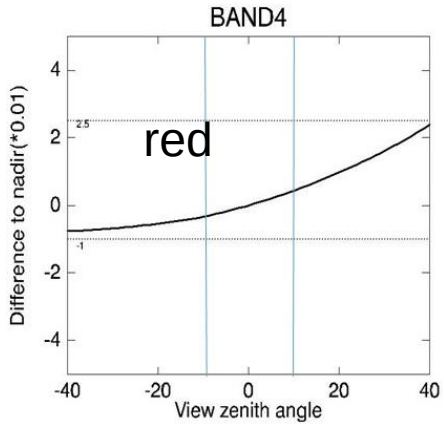
- Spectral bands adjustments
  - Using very high temporal frequency SPOT-4 (Take-5) multi-angular data set acquired during 6 months over an area in Arizona
- Spectral bands adjustments
  - Using large amount of Hyperion data over most biomes
- Prototype atmospheric correction to be tested using synthetic data provided by ESA

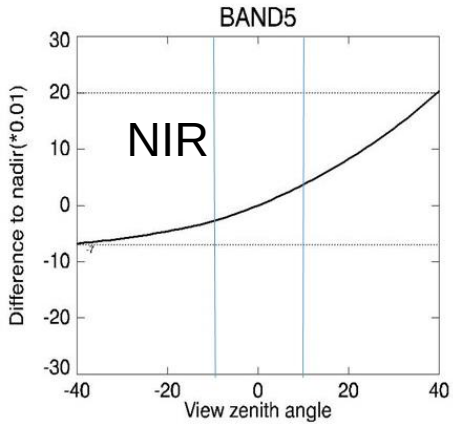
BRDF Adjustments & Modeling

- DIRSIG model
  - to facilitate scene generation to support the development for several biomes
  - enable the MODIS BRDF product to be ingested to drive the spectral BRDF
  - drive texture at tens of meter pixel size
- BRDF-adjustments techniques
  - Four methods are tested using SPOT-4 (Take-5) multi-angular data (CNES)

Harvard Forest (mixed conifer and hardwoods, 19 Sept 2011







Reprojection, Tiling, Compositing (WELD)

- Each Landsat-8 L1T and Sentinel-2 L1C acquisition should be independently reprojected into fixed geolocated tiles defined in the global sinusoidal equal area projection
- Best-pixel selection compositing: select the “best” pixel observation over the compositing period
- Compositing by inversion of a BRDF model
- Correction factors for Landsat-8

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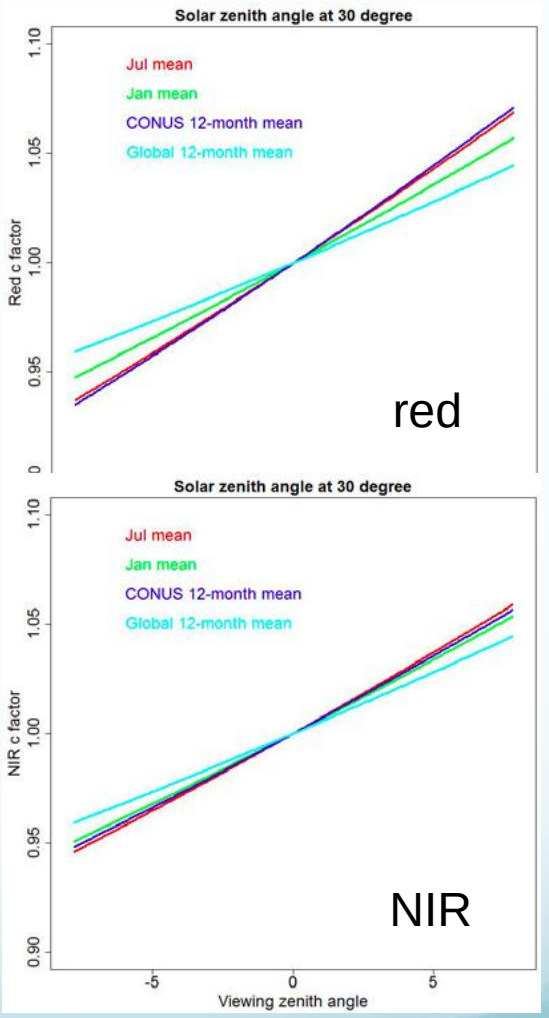

NASA Earth Exchange (NEX) Sentinel-2/ Landsat-8 Activities

- **Storage Components**
  - Currently stores ~1.4 PB of the Landsat archive
  - The existing WELD-like provenance-aware storage system was extended to Sentinel-2/Landsat processing
  - Cloud compute architecture as part of the OpenNEX implementation to provide rapid access to collaborators and researchers
    - basic analysis of Landsat data with atmospheric correction and scaling up to multiple cores for processing thousands of Landsat scenes
    - Amazon Web Services (AWS) cloud storage and compute infrastructure (https://nex.nasa.gov/opennex).
    - as part of the Sentinel-2/Landsat-8 intercomparison and higher product algorithm testing, a sandbox environment will be provided in AWS with NEX provided virtual machines that will have all the necessary tools, codes and data mounts for anyone to replicate a workflow

NASA Earth Exchange (NEX) Sentinel-2/ Landsat-8 (cont.)

- **Compute Components**
  - A large-scale distributed computing architecture is in place for reducing compute cost and efficiency
  - The NEX modules are batch processing wrapper scripts that span thousands of compute cores in the Pleiades supercomputer all in a single run
  - Large memory system like the Endeavor in Pleiades has also been used to
    - demonstrate large-scale global as well as continental mosaicking/re-projection/re-gridding algorithms for Landsat
    - perform rapid statistical analysis basic analysis of Landsat data with atmospheric correction and scaling up to multiple cores for processing thousands of Landsat scenes

NASA Earth Exchange (NEX) Sentinel-2/ Landsat-8 (cont.)

- NEX Higher Level Product Algorithm Implementation
  - Retrieval of higher level products like Leaf Area Index (LAI) and Fraction of Photosynthetically Absorbed Radiation (FPAR) from Landsat
    - Continental United States LAI from Landsat at 30-m has already been demonstrated as part of NEX core activities
  - The in-house NEX stochastic 3D Radiative Transfer algorithm along with the Neural Network model from collaborator Fred Baret (INRA, ESA) are implemented and tested with Landsat 8 data and consistency testing is currently being performed with Sentinel-2

NASA Earth Exchange (NEX) Sentinel-2/ Landsat-8 (cont.)

- NEX Products Intercomparison
  - Test bed and packaged compute environments for performing rapid intercomparison activities
    - surface reflectance consistencies (both temporally and spatially) between Sentinel-2, Landsat-8, MODIS
    - quality filter consistency for aerosols, clouds in Sentinel-2/Landsat-8 and reflectance uncertainty characterization
    - basic analysis of Landsat data with atmospheric correction and scaling up to multiple cores for processing thousands of Landsat scenes
  - Standard post processing related to intercomparison such as re-gridding, reprojection and mosaicking
    - A large part of the processing chain has already been implemented as part of the WELD project

Towards L8-S2 Full Synergy

- Preparatory work on Sentinel-2 underway
  - Results will be presented on Apr 22 (afternoon) at the Joint Focus Area Science Team meeting in College Park, MD
- Multi-Source Land Imaging proposals under review – international panel Feb 9-11
  - Selected proposals will form MSLI Science Team
  - Anticipated ~3-4 proposals on S2-L8, ~2-3 on others sensors, e.g. S1, CBERS, IRS, etc.
  - Expect to start mid-summer 2015
- Participation in Sentinel-2 workshops
  - ESA workshop on Mapping Water Bodies - Mar 18, 2015
- Joint NASA LCLUC-EARSeL workshop in conjunction with the LCLUC Science Team meeting Apr 2016 (20th anniversary) in DC area
  - Overarching theme: Use of Multi-Source Satellite Data for LCLUC Science and Applications

Thank You